reaper is a high quality machine but is imported, while the Al-Badar Agricultural Engineering Works' machine is locally made, but its performance is not yet established.

The Jhejiang Model 140 double-disc Harvester is available from Sahiwal Trading Corporation in Multan. The reaper and the pedestrian tractor upon which it is attached are manufactured by the Wenzhou Harvester Plant in China. The pedestrian tractor is of cast iron with a 7 hp diesel engine. Tractor weight with reaper is 324 kg. The reaper uses two cutting discs mounted on a horizontal rotating arm to cut a 1.4 m swath of grain while rotating fingers above the cutting discs lay the grain in (untied) sheaves. The reaper can be removed from the pedestrian tractor so that the tractor can be fitted with a plow or cart, or used as a source of power for a pump or mill. The price of the Jhejiang tractor with reaper attached is Rs 30,000 (US$ 1,400.)

The pedestrian reaper has not been accepted in the Multan area because it is too slow (0.2 ha/hour) for farmers who see others using tractor reapers or combines. The approximately four inch high stubble is too high for some farmers.

In comparing the Kubota reaper with its reciprocating sickle, and the Jhejiang reaper with its rotary cutting mechanism, I believe that the Jhejiang reaper is the more rugged and more easily repaired under primitive conditions.

I recommend that the ASSP program purchase a Jhejiang Model 140 pedestrian reaper for the applied research aspect of the program and use it along with an Al Badar (in Mardan) Kubota-type reaper in the next wheat harvest. If the Jhejiang 140 pedestrian reaper performs satisfactorily, others should be purchased and used for applied research in Afghanistan.

THRESHER

Threshers made in Pakistan, like those made in Egypt and Turkey, are designed to reduce the straw to boosha and separate out the wheat kernels in one operation. Pakistan threshers are not "all-crop" machines that can be used to thresh soybeans, sunflower, grain, etc. as are North American and European threshers which do not mutilate the straw. Threshers designed to make boosha utilize the largest part of energy in hammer milling the straw into boosha and driving the large fan which sucks the boosha away from the grain and blows it out of the machine.

The long arm rigid hammer threshers with a small (12 x 6 inches) feed opening into the end of the cylinder was most common fifteen years ago. It has since been replaced by a smaller diameter, longer cylinder thresher with a feed opening about 4 ft long x 6 inches high and parallel to the cylinder. The newer

machines also have a powered feeder so that the threshers can be fed more easily and not easily "slugged".

Safety is of slight concern in the design of Pakistani threshers: gib keys stick out of pulleys and long unshielded PTO shafts and unshielded belts and shafts near the clean grain chute are very common.

Some options of merit include:

a. A slip clutch on the PTO drive line on the Batala Model 9090 (not all Model 9090 threshers have a slip clutch).

b. A short shielded PTO from the tractor to the thresher on the Naeem thresher. This design improves safety and eliminates the opportunity for out-of-balance long PTO shafts.

c. Cylinder teeth (also called "spikes" and "cutters") bolted, instead of welded, to the cylinder bars so that they can be reversed for double life and replaced in the field. Batala, Ittefaq Industries, Taj Zari Industries, and Seth M. Tufail and Sons, all of Faisalabad, have this feature in that lugs bolted to the cylinder bars hold the bolt on which the "cutter" swings. Roomi Industries makes the cutter with a 1/2 inch NC stud welded to the end of each "cutter". The stud fits into holes drilled into the cylinder bar. This is a very clean design making it easy to reverse cutter edges or to remove.

d. Folding wheels. The height of the feed opening on Pakistani threshers is fatiguing to farm workers. By folding the wheels, the height of the feed opening can be lowered to provide a less tiring situation for those feeding the thresher.

e. An aspirator on the clean grain delivery chute. Some threshers with a fan to blow air across the grain cleaning sieves have a duct running from over the clean grain chute to the fan inlet. This allows removal of chaff or straw pieces which were not removed by the reciprocating screens.

f. A clean grain chute at the end of the thresher other than that to which the PTO is connected. This is an elementary safety design factor, but one which is not seen on all PTO threshers. In fact, a manufacturer may not always place the PTO at the same end of all his models.

g. A powered feeder to provide even feed to the cylinders. This feature is seen on more and more threshers.

h. Hard facing of the cylinder teeth by welding a bead on the working edge of the tooth with hard facing rod.

A comparison of thresher features is shown as Appendix E.

I recommend the following PTO threshers for use in Afghanistan:

Naeem and Co.(Faisalabad) with fan over screens, short PTO	Rs 40,000
Batala (Faisalabad) Model 9090 with slip clutch	Rs 37,000
Roomi Ind. (Mian Channu) cutter stud bolts to cylinder, solid discs hold cylinder bars, well made	Rs 38,000
Lal Hussain Eng. (Okara) well made, solid discs for cylinder	Rs 40,000
Mughal Farm Mach. Mfg. (Daska) 4.5 ft long cylinder, well made	Rs 30,000
Pakistan Engineers (Okara) 5 plates holding cylinder bars, well made, retractable wheels, 2 x 3/8 cross-section cutters	Rs 36,000
Taj Zari Ind. (Faisalabad) aspirator duct from clean grain chute to fan supplying air over screens, hard-faced cutters	Rs 40,000
Seth M. Tufail & Sons (Faisalabad) 5 solid discs hold cylinder bars, 3/8 x 1.5 inch cutters	Rs 37,000

"SELF-POWERED" THRESHER

"Self-powered" threshers are those with their own engines and are worthy of attention. If threshing can be performed with a 12 or 16 hp stationary engine, a 45 hp tractor is not tied up in the stationary work of threshing but can be used in mobile work such as plowing or hauling goods. When threshing season is ended, the engine can then be used to power an irrigation pump, grain mill, etc.

In some countries, such as Indonesia, Philippines, and Taiwan, small portable threshers with 5 hp engines are very popular for threshing rice. Since these threshers do not break up the straw or clean the grain by aspiration their output of grain is very satisfactory: approximately one-half ton of rough rice per hour.

To make boosha while threshing wheat demands more power. Thus, a small thresher powered by a 12 to 16 hp engine will probably have an output of one-quarter ton of grain per hour.

Mughal Farm Machinery Manufacturing Co. was the only company in Pakistan where Mr. Arif and I found manufacturing of "small" threshers meant to be powered by a 12 to 16 hp stationary engine. These threshers were being made for an order from Nigeria. The Mughal self-powered thresher converts the straw into boosha and is a scaled down model of the PTO threshers. I estimate that it will thresh out about one-quarter ton of wheat per hour.

The Mughal "self-powered" thresher (Rs 18,000) with a 16 hp Chinese diesel engine (Rs 17,000) has a price of Rs 35,000 fob Daska. I recommend that the ASSP project purchase one of these units immediately and test it with the sheaves of wheat stored in Peshawar. If the tests are satisfactory, more threshers can be obtained from Mughal since they build their machines from templates and assemble them on a small production line. Mughal does not keep the small "self-powered" threshers in stock, but manufactures them only upon receipt of an order.

GRAIN CLEANER

A small grain cleaner powered by a fractional horsepower electric motor or a small gasoline engine would be useful in the ASSP godowns handling seed wheat. No small grain cleaners can be found for sale in Pakistan.

Lal Hussain Engineers in Okara does have, on loan, a small grain cleaner, the "Optima" made by Paul Auwarter Co. in Germany. The cleaner has a wooden frame, various screens for different seeds, and is powered by a 0.32 kw electric motor. Cleaning is accomplished by the combination of reciprocating motion, angle of screen, and air velocity. An instruction sheet on the cleaner specifies suggested screens, fan settings, and windboard settings for various seeds. The grain cleaner was loaned to Lal Hussain Engineers by the Farm Machinery Institute (FMI) in Islamabad. Lal Hussain is to make some units for several governmental organizations. However, no work had been done as of the 17th of July. The Lal Hussain version of the "Optima" cleaner will have a steel frame and cost Rs 20,000.

The IRRI reciprocating grain cleaner is a simple all-steel machine that could be made in Pakistan. A telex requesting a set of engineering plans has been sent to IRRI. Upon receipt of the plans, a manufacturer such as Mughal Farm Machinery Company in Daska, Lal Hussain in Okara, or Roomi Industries in Mian Channu could be engaged to make the cleaner.

FARM TRAILER ("TROLLEY")

The trolley is a necessary farm tractor accessory for at least two reasons. It provides transport of farm inputs and produce over rough roads and terrain, and is a source of wages in hauling goods when the tractor is not needed on the land. There are many workshops making trolleys in Pakistan since building a trolley consists primarily of welding rectangular steel sheets and channels into a box and attaching the springs, axle and wheels. There is a minimum of machining and except for the fitting of the bearings, no precision work. However, some workshops base their work on better designs than others and some workshops do good welding while others use poor equipment or employ poorly skilled operators.

The major options for the single-axle farm trailer as used in Pakistan are:

a. Springs or solid connections between axle and frame. In the flat areas of Punjab, solid connections are used while in mountainous areas, springs are used. Trolleys going to Afghanistan should be equipped with springs.

b. Hinged or solid sides of the trailer box. The end gate should be hinged, but the front and side of the trailer box should be welded together for strength.

c. Single wheels or dual wheels. A good design can be obtained in either mode. It depends upon the load to be carried and the size and ply of the tires.

d. Tilt bed or fixed. A tilt bed requires a hydraulic cylinder and a sub-frame for the trailer box. Since the ASSP trolleys will not be used to haul sand or gravel on a daily basis, the trolley should be kept simple and a fixed bed chosen.

e. Size. The trolleys have no brakes and will be used with a 45 hp tractor (MF-240). Thus, there is a good reason from the viewpoint of safety not to go larger than an 11 x 6.5 x 2 ft. box.

f. Flat bed or a lower bed with wheel wells. The flat bed is easier to build and wheeled implements can be rolled onto it easily, but the bed will be higher above the ground than one with wheel wells. When the trolley is used for hauling loads such as sand or gravel, which must be shoveled up into the trolley, a trolley with wheel wells is preferred since workers are not required to shovel material so high. The flat bed design appears to be the more suitable for ASSP needs.

I recommend the following farm trailers (trolleys):

JECO (Gujranwala) 11 x 6 x 2 ft box, springs, single axle, 2 tires	Rs 38,000
American Motors Co. (Rawalpindi) box, springs, single axle, 4 tires	Rs 38,000

APPENDIX A

SCOPE OF WORK

POSITION: Agricultural Equipment Specialist

COMPONENT: Agricultural Development and Training (ADT)

CANDIDATE: Joseph K. Campbell

DURATION: 4-6 weeks, mid-June to August

The Agriculture Equipment Specialist will report to the ADT Director through the ADT Advisor. His duties will include:

1. Review the structural quality and efficiency of all agricultural machinery manufactured or available in Pakistan which is suitable for use by ADT demonstration centers or for sale to Afghan farmers. Examples of such equipment are threshing machines, walk-behind reapers, seed drill and power tillers.

2. Conduct field tests where possible on all the above mentioned equipment.

3. Make recommendations for local procurement of equipment that could be successfully used in Afghanistan.

4. Provide recommendations on designs appropriate to Afghan conditions which could be manufactured in Pakistan, e.g., IRRI motorized threshing machines.

5. Conduct equivalent testing outside of the agricultural cycle in those cases where machinery cannot be tested during the appropriate season. This might require an additional trip at the time of the wheat harvest; such trip to be authorized separately.

6. The Agricultural Equipment Specialist's report, in conjunction with other equipment studies accomplished by the project, FAO and other private, voluntary organizations, will serve as the basis for purchasing demonstration equipment for ADT and for recommending specific agricultural machinery commodities for cross-border, free market trade.

APPENDIX B

LIST OF COMPANIES AND PERSONS VISITED

LAHORE

Millat Tractors Limited
Sheikhupura Road; P.O. Box 1147; Lahore
Telex 44888 MTL PK FAX (042)71197

Mr. Sohail Bashir Rana, Gen. Mgr., Marketing	Tel 711020
Engr. Bashir A. Chaudhry, Sr. Mgr., Farm Mach.	Tel 711021-25
Mr. Nadeem Ahmed, Deputy Mgr., Farm Mach.	Tel 711021-25
Mr. Anwar Ahmad, Deputy Mgr., Quality Control	Tel 711021-25

Descon Engineering (pvt) Limited
Akhavan House
38 Sir Agha Khan III Road (Davis Road), Lahore
Workshop at: Haji Mehr Din Road; Badami Bagh, Lahore
Telex 44326 DSCON PK FAX (042) 306704

Mr. Razak Dawood, Mgr.Director,	Tel (042) 301563-4
Eng. Sajjad Haider Malik, Asst. Eng.	Tel (042) 285304

Sayyed Machinery Limited
65 Shahrah-e-Quaid-e-Azam, Lahore-3 or
40 Ahmed Block; Garden Town, Lahore Tel 865868-69, 867485
Telex 44190 SAYYED PK.

Mr. Khalid Masud Butt, Chief Exec. Tel 312932 (home)

Shadab Farm Industries (Regd)
Sheikhupura Road, near Millat Tractors Ltd.
Shahdra, Lahore - 35

Mr. Mohammad Qasim Bhatti Tel 711823, 711824

Rashad Motors & Tractors
Sheikhupura Road, Lahore-35

Mr. Malik Muhammad Igbal, Chief Exec. Tel 711823-24
Mr. Igbal is also Managing Director
of AGRAR, Manufacturers, Distributors,
Formulators-Importers
Chowk Ganga Ram
16, Queens Road, Lahore Tel 711823-24

MARDAN

Al-Badar Agricultural Engineering Works
Malakand Road, Takht-i-Bhai
Mr. Haji Noor Mohammad, Prop. — Tel 92239

DASKA

United Agro Engineers
Circular Road, Daska

Mr. Mirza Mohammad Younas, Mgr. Dir. — Tel 2750 (Res: 2720)

Green Land Engineers
Circular Road, Daska

Mr. Mohammad Iqbal Mughal, Mgr. Dir. — Tel 2864 (Res: 2264)

Saeed Brothers Agro Engineers
Circular Road, Daska

Mr. Mohammad Hanif

Mughal Farm Machinery Manufacturing Company
Circular Road, Daska Sialkot

Mr. Misza Mohammad Ismail, Mgr. Dir. — Tel 2939 (Res: 2239)
Mr. Mohammad Yaqub, (son) Works Mgr. — Tel 2939

Awami Engineering Works
Circular Road, Daska

Mr. Masood

FAISALABAD

Ittefaque Industries (Regd.)
Samundri Road, Faisalabad
Cable: ITTEFAQUE

Ch. Mohommad Sadiq, Mgr. Partner — Tel 41960, 41961, 46471

APPENDIX B (Continued)

Batala Industries (Regd.)
Samundri Road, Faisalabad

Ch. Bashir Ahmed, Mgr. Partner — Tel 41510, 42095 (factory)

Naeem &' Company (Regd.)
Samundri Road, Faisalabad

Mr. Mirza Mohammad Naeem, Mgr. Partner — Tel 45771, 40723
Mr. M. Saleem Mirza, Mgr. Partner — Tel 45711, 40723
Mr. Khalil — Tel 45771, 40723

Taj Zari Agriculture Industries
Samundri Road, Faisalabad

Mr. H. Mohammad Saeed, Mgr. Dir. — Tel 42788 (factory), 45142
Mr. Faizan M. Khan, Director — Tel 45142
Mr. Sieb, Foundry Superintendent — Tel 42788

Seth M. Tufail & Sons Agricultural Machinery & Implements
Samundri Road, Faisalabad

Mr. Akbar

Sartaj Industries
Samundri Road, Faisalabad

Mr. Bashir Ahmed — Tel 42771, 43671

OKARA

Lal Hussain Engineers
Grand Trunk Road, Okara

Mr. Farasat Ali (also owns Ali Bai Engineers and two other workshops) — Tel 4183

Al Madina Engineers
Grand Trunk Road, Okara

Mr. Mohammad Alam — Tel 3102

PURPOSE OF REPORT

The purpose of this report is to recommend specific farm implements for use in Afghanistan. The farming techniques of Pakistan and Afghanistan are similar. Being neighbors, machines and spare parts can easily move across the border. Thus, nearly all of the recommended implements are produced in Pakistan.

I arrived in Pakistan and Peshawar on July 2, 1990 and departed on August 10. The Scope of Work guiding me can be found in Appendix A.

Engineer Arif Javid, who worked with me from July 9 to August 9, provided invaluable help in obtaining information and equipment, visiting workshops, and providing insights. His knowledge of the Pakistani farm machinery industry and past work as an engineer for the IRRI (International Rice Research Institute) farm machinery project in Pakistan has been very useful in completing my task. Unfortunately the Eid holiday, the August 9th and 10th Muharram holiday, and canceled air flights prevented us from visiting as many workshops and institutes as planned. A list of the companies and persons visited can be found in Appendix B. Appendix C is a list of the memos I wrote to Dr. Dale Haws, Agricultural Sector Support Project (ASSP), during the course of my visit to Pakistan.

This report discusses both the advantages and disadvantages of implements required throughout the agricultural calendar. It also recommends specific machines for use by ASSP in research and for sale through selected bazaars in Afghanistan.*

If a manufacturer is not listed, it should not be inferred that the manufacturer's implement is inadequate; Mr. Arif and I may not have had the opportunity to visit the workshop. The cliche that the "manufacturer reserves the right to change the construction of the machine at any time" applies to farm machinery in Pakistan. Most agricultural implements are not made to standardized specifications, except for a few manufacturers such as Millat Tractors which may subcontract implement manufacture to others while holding them to strict engineering and manufacturing standards. Therefore, the buyer must order implements identical to one on the manufacturer's lot and inspect the machine before acceptance. Prices for many machines are given in this report, but these are prices quoted to me and are not necessarily the final sale price.

* These bazaars are located at Khwaja Mulk (Kandahar), Shah Joy (Zabul), Sheikh Abad (Wardak), Yajha Khel (Paktika), and Baraki Rajan (Logar).

Faisal Industries
Grand Trunk Road, Okara

Mr. Javid Iqbar

Pakistan Engineers
Grand Trunk Road, Okara

Mr. Abdul Rauf Tel 3972

GUJRANWALA

JECO (Pvt) Ltd.
P.O. Box 46, Grand Trunk Road,Gujranwala. near Glushan-e-Iqbal
Telex: 4528 JECO PK
FAX: (431)84212 "for JECO"

Mr. Mirza M. Amin, Mgr. Dir. Tel 81343, 82777

Millat Industries
Grand Trunk Road, Gujranwala

Mr. Abdul Rashid Tel 83943, 82542

Madina Farm Industry
Al-Fateh Chowk; Grand Trunk Road, Gujranwala

Mr. Mohammad Yousaf Tel 42205, 82305

Rana Farm Industries
Grand Trunk Road, Gujranwala

Mr. Naseer Ahmed

Shadab Industries
Purana Bijli Ghar Road, Gujranwala

Mr. Ihsan Ullah

SHEIKHUPURA

Farm Development Industries (Pvt.) Ltd.
Pir Bhar Shad; Lahore Road, Sheikhupura

Mr. Nazir Ahmad Alvi, Mgr. Dir.	Tel (04931) 4123, 4110

ISLAMABAD

Farm Machinery Institute
National Agricultural Research Centre
Park Road, Islamabad
TELEX: 5604 PARC PK

Dr. Abdul Shakoor Khan, Dir.	Tel 820370, 820380, 414597(home)
Engr. M. Tahir Anwar	Tel 820370, 820380
Engr. Azhar Igbal Mufti, Sr. Eng.	Tel 820370, 820380

American Motors
75 Kashmir Road, Rawalpindi

Mr. Mohammad Akmal, Works Supt.	Tel 66884

MULTAN

Ali Industries
18 Azmat Wasti Road

Latif Engineering Works
Saddo Sam

Mr. Abdul Rashid (brother of Latif)

Lucky Brothers
Saddo Sam

Murad Mechanical Works
Nusrat Road

Mr. Mohammad Raf

Sahiwal Trading Corporation
Dera Adda, Saddar Road

Mr. Zahid Azmat (Salesman) Tel 74828, 73267

MIAN CHANNU

Bodla Engineering
Grand Trunk Road
(Bodla is going out of farm machinery manufacturing)

Mohammad Saleem Bodla

Jamal Industries
Grand Truck Road

Mohammad Rafiq

Ghazi Industries ltd.
Grand Trunk Road.

M. Arshid Ghazi, Director Tel (0448) 3777, 3877; rex. 3817

Roomi Industries
Grand Trunk Road
Tel 3513 -3813
Res 3717 Gram "ROOMI"

Mian Fazal Haq, Partner
Mian Lami-ul-Haq, Son and Partner

APPENDIX C

MEMOS
(To Dr. Dale Haws from J. K. Campbell)

10 July 1990	Observations From Inspection Of Trailers and Threshers
11 July 1990	Machinery Fact-Finding Trip to Lahore
26 July 1990	Small Self-Powered Thresher
26 July 1990	Inspection of Single-Axle Trailer ("Trolley") at American Motors Company in Rawalpindi on 24 July 1990
27 July 1990	Proposed Farm Implement Fact-Finding Trip to Multan, Mian Channu, and Quetta
29 July 1990	Implement Packages For Afghanistan
31 July 1990	Inspection and Load Testing of Single-Axle Trailer ("Trolley") at American Motors Company in Rawalpindi on 30 July 1990.
2 August 1990	Farm Machinery References

APPENDIX D

REFERENCES

The Agricultural Survey of Afghanistan, Second Report, FARM POWER, The Swedish Committee for Afghanistan, Vol. 1, April, 1989.

K. Scott Eubanks, "Farm Machinery: 16 Provinces In Afghanistan, Analysis and Recommendations," Development Alternatives, Inc., Feb. 11, 1990.

Roy E. Harrington, "Farm Mechanization Strategies For Afghanistan," Feb. 15, 1989.

Handbook of Agricultural Machinery Manufacturers In Pakistan, Farm Machinery Institute, NARC; Islamabad, 1983.

"New Khan Wheat Thresher Test Report," Farm Machinery Institute Testing Substation, Directorate of Agricultural Engineering NWFP, Tarnab, Peshawar, 1987

H.H. Smith, et al., Area Handbook for Afghanistan, 4th Ed., Superintendent of Documents, Washington D.C., 1973.

APPENDIX E

P.T.O. POWERED CUTTER TYPE THRESHER

NAME OF MANUFACTURER	SIZE IN FEET	NO. OF BLOWERS	CUTTERS				PTO		WHEELS	SAFETY	
			FIX	BOLTED	REVERSED	HARD FACED WELD	SHAFT LONG/ SHORT	ON GRAIN SPOUT OR OPPOSITE	FOLDING OR FIX	SLIP CLUTCH	GUARD FOR PTO SHAFT
BATALA AGRI MACHINERY CO SAMUNDARI RD FAISALABAD	4	2	-	YES	YES	YES	L	OPP	FOLDING	YES	-
NAEEM & CO SAMUNDARI RD FAISALABAD	4	2	-	YES	YES	YES	S	OPP	FOLDING	NO	YES
TAJ ENG. WORKS SAMUNDARI RD FAISALABAD	4	2	-	YES	YES	YES	L	OPP	FOLDING	NO	NO
ITTEFAQ INDUSTRIES SAMUNDARI RD FAISALABAD	4	2	-	YES	YES	NO	L	ON GRAIN SPOUT	FOLDING	NO	NO
SETH M. TUFAIL&SONS SAMUNDARI RD FAISALABAD	4	2	YES	-	-	YES	L	OPP	FOLDING	NO	NO

P.T.O. POWERED CUTTER TYPE THRESHER

NAME OF MANUFACTURER	SIZE IN FEET	NO. OF BLOWERS	CUTTERS				PTO		WHEELS	SAFETY	
			FIX	BOLTED	REVERSED	HARD FACED WELD	SHAFT LONG/ SHORT	ON GRAIN SPOUT OR OPPOSITE	FOLDING OR FIX	SLIP CLUTCH	GUARD FOR PTO SHAFT
MURAD AGRO MECHANICAL WORKS NUSRAT ROAD MULTAN	4	1	-	YES	YES	NO	L	OPP	FOLDING	NO	NO
LATIF ENGG WORKS RAILWAY ROAD SADDOSAM MULTAN	4	1	-	YES	YES	NO	L	OPP	FOLDING	NO	NO
GHAZI INDUSTRIES G.T. ROAD MIAN CHANNU	4	1	-	YES	YES	YES	L	OPP	FOLDING	NO	NO
JAMAL INDUSTRIES G.T. ROAD MIAN CHANNU	4	1	YES	-	-	NO	L	OPP	FIX	NO	NO
ROOMI INDUSTRIES G.T. ROAD MIAN CHANNU	4	1	-	YES	YES	YES	L	OPP	FOLDING	NO	YES

APPENDIX E (Continued)

P.T.O.POWERED CUTTER TYPE THRESHER

NAME OF MANUFACTURER	SIZE IN FEET	NO. OF BLOWERS	CUTTERS				PTO		WHEELS	SAFETY	
			FIX	BOLTED	REVERSED	HARD FACED WELD	SHAFT LONG/ SHORT	ON GRAIN SPOUT OR OPPOSITE	FOLDING OR FIX	SLIP CLUTCH	GUARD FOR PTO SHAFT
MUGHAL FARM MACHINERY MFG. CO. CIRCULAR RD DASKA	3	1	-	YES	YES	YES	S	OPP	FOLDING	NO	YES
MUGHAL FARM MACHINERY MFG. CO. CIRCULAR RD. DASKA	4	1	-	YES	YES	YES	L	OPP	FOLDING	NO	NO
AWAMI ENGG. WORKS CIRCULAR RD DASKA	4	1	YES	-	-	NO	L	OPP	FIX	NO	NO
SAEED BROS CIRCULAR RD DASKA	4	1	-	YES	YES	NO	L	OPP	FIX	NO	NO
LAL HUSSAIN ENGG. G.T. ROAD OKARA	4	2	-	YES	YES	YES	L	OPP	FOLDING	NO	NO

APPENDIX E (Continued)

P.T.O. POWERED CUTTER TYPE THRESHER

NAME OF MANUFACTURER	SIZE IN FEET	NO. OF BLOWERS	CUTTERS				PTO		WHEELS	SAFETY	
			FIX	BOLTED	REVERSED	HARD FACED WELD	SHAFT LONG/ SHORT	ON GRAIN SPOUT OR OPPOSITE	FOLDING OR FIX	SLIP CLUTCH	GUARD FOR PTO SHAFT
ROOMI INDUSTRIES G.T. ROAD MIAN CHANNU	5	1	-	YES	YES	YES	L	OPP	FOLDING	NO	YES
BISMILLAH AGRO ENGG. CIRCULAR RD DASKA	4	1	-	YES	YES	NO	L	OPP	FOLDING	NO	NO
FAISAL AGRI INDUSTRY G.T. ROAD OKARA	4	2	-	YES	YES	NO	L	OPP	FOLDING	NO	NO
PAKISTAN ENGG. WORKS G.T. ROAD OKARA	4	2	-	YES	YES	YES	L	OPP	FOLDING	NO	NO

TRACTOR POWER

Insufficient oxen power demands that tractors be used in Afghanistan if food production is to increase. Prior to the war 90% of Afghan farmers had their own oxen; by 1987 only 43% had their own oxen. In 1989 it was estimated that 500,000 oxen were required to reach prewar levels. (See Second Report, Farm Power, pg. 5, References, Appendix C.)

I recommend a 45-50 horsepower tractor such as the Massey Ferguson 240 (MF-240) which is built in Pakistan by Millat Tractors Ltd. in Lahore. The MF-240 is a good tractor and has been well accepted by farmers around the world. Since the MF-240 is built in Pakistan, and is probably 90% local content, repairs and service are readily available.

The MF-240 lists for Rs. 166,500 ($7,759). It has an ASAE (American Society of Agricultural Engineers) category I 3-point hitch and a 540 rpm PTO (power take off). However, the tractor should be purchased with the following options in order to secure efficiency in the field:

Front end weights (at least 5) @	Rs 270 each
Water ballasting tool	Rs 100
9-hole drawbar	
Fixed hitch which bolts to differential housing to accept trolley and thresher tongue rings. The fixed hitch must be of a type that does not interfere with using the PTO.	
Roll over bar (if available)	
Rear view mirror	

BASIC FIELD IMPLEMENT PACKAGE FOR AFGHANISTAN
(For 45-hp tractor such as MF 240)

9-tine field cultivator	Rs 7,000
Grain Drill (fert. box & inside wheels)	11,000
PTO thresher	38,000
Farm trailer ("trolley")	38,000
2-bottom moldboard plow*	7,300
	Rs 101,300 ($4,720)

* For plowing land which has been fallow due to the war. The tine tiller would be used for secondary tillage after the plow.

IMPLEMENTS FOR APPLIED RESEARCH IN AFGHANISTAN

Two-bottom, 26-inch disk plow	Rs 19,000	($ 885)
Right-hand offset disk	30,000	(1,400)
"Spring" drill	10,000	(466)
Pedestrian reaper (Jhejiang)	30,000	(1,400)
Tractor mounted reaper	22,000	(1,025)
Self-powered thresher with 16 hp diesel	35,000	(1,630)
Minimum tillage drill ("spring" drill)	10,000	(466)
Seed cleaner	20,000	(932)

It is important to note that the basic implements - field cultivator, two-bottom moldboard plow, grain drill, PTO thresher, and tractor trailer - only cost about $5,000 for the best equipment made in Pakistan.

I recommend that the ASSP project not purchase implements other than "top of the line". The increased risk of a parts failure in Afghanistan due to a machine being built with second hand bearings, inadequate material, or poor welding, is not worth the few rupees "saved."

TILLAGE IMPLEMENTS

The field cultivator - called a "tine tiller" or "cultivator" in Pakistan - is the most widely used tractor tillage implement in Pakistan. This is understandable since the tine tiller does a minimum of soil inversion and prepares the soil in a manner similar to that of the bullock-drawn ard (country plow). Other tractor tillage tools to consider are the moldboard plow, disk plow, offset disk harrow, and rototiller, all of which are manufactured in Pakistan. However, these are manufactured in small quantities when compared to the tine tiller.

The tine tiller should be part of the basic implement package for Afghanistan since it fits into the farming practices of farmers who have used bullocks in the past.

The moldboard and disk plows, capable of cutting off roots and soil inversion, is very effective in plowing land which has lain fallow for several years. However, while the operator of a tine tiller requires little instruction, moldboard and disk plows must be used according to a plan. The operator must be able to visualize the layout of the field in headlands and lands so as to create the fewest number of back furrows (one furrow thrown on top of another and producing a high spot in the field) and dead furrows (a furrow which is not filled and thus a low spot in the field).

The plowing depth for a disk plow is controlled by the angle of the disks and the weight of the implement. More weight will cause it to plow more deeply. However, the plowing depth of a moldboard plow is controlled by the hitch and the "bottom suction". When the point of the plowshare wears away, bottom suction disappears and the plow will not reach the desired depth. Therefore, moldboard plows for Afghanistan should utilize plows with adjustable plow points instead of gunnel shares or throw-away plowshares.

The rotary tiller prepares a good seed bed. However, with the exception of paddy rice production where a tractor-powered rotary tiller actually helps to push the tractor along while puddling or preparing the soil in a flooded condition, the rotary tiller is an expensive implement to operate. In addition, for many upland crops it pulverizes the soil more than is desirable from the standpoint of soil structure.

The mounted cum trailed offset disk harrow with 24 or 26-inch diameter disks can be used for plowing light (sandy) soils. Disks are normally set 9-inches apart. For a tractor such as the MF 240, there should not be more than 14 disks: seven in front and seven in the rear. On heavy (clay) soils the offset disk can be used for secondary tillage.

TINE TILLER

A tine tiller with nine tines (1.9 m working width) or eleven tines (2.6 m working width) will be satisfactory. With traction limited, a 9-tine tiller should be chosen for heavy soils and an 11-tine for light soils. Since neither specific soil conditions nor if the tractor will be properly ballasted for maximum drawbar pull is known, it will be best to purchase the 9-tine units. The tine tillers all use heat treated reversible shovels (shoes).

The tine tillers in Pakistan are all made to the same design except for two options. On some tine tillers the frame is made more rigid by using a torque tube made of steel tubing and mounted above the angle steel frame; on others, rigidity is increased by bolting steel bars diagonally across portions of the angle steel frame. I believe the torque tube is better.

The second difference between designs is the means by which an obstruction forces the spring-loaded tine out of the soil. Most tine tillers have the tine attached to the frame by a pivot point with the shovel on the bottom end of the tine and a set of tension springs on the top end. When the shovel hits an obstruction, the spring stretches and allows the shoe end of the tine to deflect rearward and upward. The "toggle" type of tine tiller utilizes a spring loaded toggle mechanism which provides

an upward lift when the shovel strikes an obstruction. The toggle-type tine tiller does a better job of pulling the shovel away from an obstruction, but at the expense of a mechanism with three times as many pivot points.

At least one manufacturer makes a tine tiller in which the tine works against a compression spring instead of a tension spring. I do not recommend this design. The compression spring has a limited range of travel and there is the opportunity for soil to wedge between the spring coils in the spring retainer and thus prevent maximum spring deflection.

The following tine tillers appear to be well constructed and should provide satisfactory service:

Farm Development Ind. (Sheikhupura) model FC-9 9-tine unit with toggle. FDI does good heat treating and builds a good machine.	Rs 7,000
Millat Tractors MT-38 9-tine with toggle.	Rs 6,700
Lal Hussain Eng. (Okara) 9-tine; torque tube and well-made	Rs 7,000
Roomi Ind. (Mian Channu) 9-tine; torque tube and well-made	Rs 7,000
American Motors Co. (Rawalpindi) 9-tine; torque tube and well made, but check for lock washers	Rs 7,000

TWO-BOTTOM MOLDBOARD PLOW

Moldboard plows in Pakistan do not have coulters or jointers and most are set up with narrow-cut shares or over-cut shares. They are not purchased according to number of shares and width of share, but to the overall width of cut. Most of the tractor plows seen in Pakistan range from 9 to 14-inch bottoms. The plow should have an adjustable plow point and a general purpose moldboard. The following moldboard plows appear to be well constructed and should provide good service:

Millat Tractors MT-02/M	Rs 7,300
Farm Development Ind. (Sheikhupura) two 13-in. bottoms on 11-in. centers, good steel	Rs 4,500
JECO Agricultural Equipt. (Gujranwala) "Agrimac" 2-bottom moldboard plow with adj. point	Rs 7,500

DISK PLOW

Disk plows are most suitable for conditions such as hard dry, sticky or loose peat soil. In soils with rock ledges, the disk plow will bounce over the rocks, whereas a moldboard plow is likely to snag on them and break a plow point. One advantage to the disk plow is that it does not require as competent an operator as does a moldboard plow. However, in good soil a properly adjusted moldboard plow will do better plowing, with uniform depth and furrow inversion, than a disk plow. A two-bottom 26-inch diameter disk plow is suitable for a 45-hp tractor

The following disk plows are well made and should perform satisfactorily:

Lal Hussain Engineers (Okara) Disc plough, two 26-in. disks, tapered roller bearings	RS 18,000
Millet Tractors (Lahore) Disc plough, two 26-in disks, tapered roller bearings	Rs 19,000

OFFSET DISK HARROW

An offset disk harrow with 24-inch diameter disks can be used for primary tillage on lighter soils and secondary tillage (final seed bed preparation) to break down clods left after plowing hard ground. An offset disk harrow "mounted cum trailed" provides ease of transport yet can be trailed in operation. The disks are usually mounted on sealed roller bearings set at a 9-inch spacing along the axle. All disk plows and disk harrows made in Pakistan use imported disk blades. To pull an offset disk harrow effectively, the tractor must be properly ballasted.

The following offset disk harrows are well made and should perform well:

Lal Hussain Engineers (Okara) 24-inch disc, 7 in front and 7 in rear, disk made for right-hand offset	Rs 20,000
Millat Tractors (Lahore) MT-03M, 24-inch disc, 7 in front and 7 in rear, disk made for right-hand offset	Rs 17,800

ROTARY TILLER

Rotary tillers with a working width of 50 to 60 inches and designed for a Cat. I, 3-point hitch and a 45 hp tractor are manufactured in Pakistan as well as imported. The following rotary tillers appear to be well constructed and should do good work:

Farm Development Ind. (Sheikhupura)	
50 in., 30 tines	Rs 21,500
60 in., 36 tines	Rs 25,500
Naeem & Co. (Faisalabad)	
50 in., 30 tines	Rs 26,000
60 in., 36 tines	Rs 29,000
Millat Tractors (Lahore)	
Maschio (Italy) 50 in., 30 tines	Rs 33,500
Maschio (Italy) 60 in., 36 tines	Rs 40,500
United Agro Eng. (Daska)	
50 in., 30 tines	Rs 26,500

GRAIN DRILL WITH FERTILIZER BOX

All the seed drills manufactured in Pakistan have hoe type openers and no seed covering devices. Most of the seed drills are made in 9, 11, 13, and 15 row models. Row spacing is usually variable, but common row spacing in Pakistan is 7-inches for wheat; 14 for maize, and 30 for cotton. For a 45 hp tractor such as the M-F 240, the 11 or the 9 hoe unit should be very satisfactory for wheat.

On some machines the hoes clamp onto the frame, while on others the hoes bolt through holes in the frame. On some drills all the hoes are attached to one frame member. This is not as good a design as having the hoes attached to two frame members. When hoes are attached to two frame members, there is more room for trash to slip between the hoes.

The best seed drill for planting a wide variety of seeds is the Descon drill made in Lahore. It is a copy of the Aitchison drill from New Zealand and is equipped with "inverted T" hoes. The gear box is imported. Its price is Rs 50,000. This is the drill to recommend for a research farm, but it is too complex and expensive for planting only wheat and cotton in Afghanistan.

Naeem & Company in Faisalabad is the drill specialist in Pakistan. They build a quality drill and produce five drills per day on a 6-day work week. For the small fields in Afghanistan, drills should have the wheels mounted on the inside of the frame instead of the ends so seed can be planted close to the bounds. Inside wheel models cost about Rs 1,000 ($47) more than the end wheel models.

Naeem & Company uses plastic metering elements while some manufacturers use aluminum and others, steel. The plastic does not corrode. Since fertilizer can corrode aluminum, some manufacturers not using plastic will substitute brass for the

aluminum in the fertilizer feeding mechanisms. The drills of some manufacturers are unsatisfactory because of poor welding, rusty boxes, and second-hand bearings.

The following grain drills with fertilizer boxes appear to be well constructed and should provide good service:

Naeem & Co.(Faisalabad) 9-row with fert. box and inside wheels	Rs 11,000
Millat Tractors 9-row with fert. box and inside wheels	Rs 12,000
Seth Tufail & Sons (Faisalabad) 11-hoe, tapered box, inside wheels, aluminum fluted feed	Rs 7,500

SPRING DRILL (MINIMUM TILLAGE DRILL)

Millat Industries (no connection with Millat Tractors) in Gujranwala makes a "spring drill" which is essentially a seed drill mounted on a tine tiller. Millat Industries claim to have sold about 100 units, primarily in the Rawalpindi - Islamabad area. The farmers are not using the drills as "no-till" drills, but as minimum-tillage drills.

The Millat spring drill utilizes second-hand ball bearings in the wheels and the welding could be improved, but one of these drills should be used in the "applied research" portion of the ASSP program. The cost for a Millet "spring drill" is Rs 10,000.

TRACTOR REAPER

The reaper cuts the standing grain and deposits it in a windrow where farm workers tie the cut grain into sheaves or carry it as bundles to the threshing area. The reaper requires greater precision in manufacture than the other field machinery - tine tiller, plow, thresher, and trolley - made in Pakistan. Tractor mounted reapers are manufactured by a large number of Pakistani manufacturers. The reaper mounts on the front of the tractor and is powered by the tractor's PTO.

Another option for reaping grain is using a farm mower mounted on the tractor's 3-point hitch. The farm mower is widely used in Egypt to cut wheat. The mower does not put the grain in a windrow and people must come after the mower to gather the grain into sheaves. Although the rear-mounted tractor mower does not windrow the grain, it is less expensive than a reaper and is simple and rugged. However, no farm mowers are manufactured in Pakistan, so mowers would need to be imported from the USA or Europe.

Tractor mounted reapers are well developed in Pakistan. Other than quality of construction, the primary difference between reapers is the type of cross conveyor which moves the cut grain transversely to the right-hand side of the machine. Some models have a cross conveyor consisting of fingers mounted to an extended pitch roller chain while on others the fingers are attached to a fabric belt. The fabric belt is less expensive, but stretches with use. However, for Afghanistan I recommend reapers using the fabric belt since the belts can be repaired using local materials.

The following tractor reapers appear to be of good workmanship and should perform satisfactorily:

Sayyed Mach. Ltd. (Lahore) 7 ft., belt type, well-made	Rs 22,000
Batala Industries (Faisalabad) 7 ft., belt type	Rs 22,000
Mughal Farm Mach. Mfg. (Daska) 7 ft., chain type	Rs 22,000
Taj Zari Ind. (Faisalabad) 7 ft., belt type	Rs 22,000

PEDESTRIAN REAPER

Small self-propelled pedestrian reapers are used in some Asian countries for harvesting rice. The reaper for this purpose was developed by the International Rice Research Institute (IRRI) and the Chinese Academy of Agricultural Mechanization (CAAMS). The width of cut is 1.6 meters. The reaper mounts on an IRRI PT-3 power tiller (pedestrian tractor).

In the Philippines the reaper attachment costs approximately $550 (Rs 11,800) while the power tiller with gasoline engine is about $1,300 (Rs 27,900). The power tiller can be used for plowing, puddling and transport, but is not satisfactory for plowing dry soil. Engineering plans for the power tiller and the reaper attachment are available from the IRRI. The Mughal Farm Machinery Manufacturing Co. in Daska was a cooperator with IRRI when IRRI had a farm machinery program in Pakistan about ten years ago. Thus, Mughal would be the firm to contact if a decision is made to build such a reaper.

Kubota manufactures a pedestrian reaper very similar to the IRRI-CAAMS design.

In Mardan, the Al-Badar Agricultural Engineering Works makes a 1.3 meter reaper modeled after the Kubota reaper. The asking price for the reaper with gasoline engine is Rs 30,000. The reaper appears satisfactory for cutting wheat, but one cannot be sure until the machine has worked for a season. The Kubota

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Development Alternatives, Inc.

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PRIVATE SECTOR AGRIBUSINESS

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Prepared by Joseph Campbell for Development Alternatives Inc., and the office of the USAID Representative to Afghanistan under Contract Number 306-0204-C-00-9829-00.

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